and unusually detailed discussion. Mr. Mair has been one of the earliest and most earnest advocates of this system of 'independent engine-tests,' and has followed closely upon the steps of Messrs. Farey & Donkin, and of Sir Frederick Bramwell, in carrying out this undoubtedly correct method.

By this system, the power of the engine, and the distribution and variations of weight of steam in the steam-cylinder, are determined by the indicator in the usual way; while, at the same time, the discharge of heat into the condenser of the engine is measured by introducing a weir at the discharge from the hot-well, and, by the use of properly disposed thermometers, calculating from the readings so obtained the number of thermal units of heat-energy thus carried away from the engine. The sum of the quantities of heat carried off, the heat converted into power and utilized as mechanical energy, and the heat wasted in various ways in its passage through the machine, should evidently be equal to the heat received from the boiler. The latter quantity is usually capable of easy determination; and the power of the engine as shown by the indicator, and the losses in the condensing water, are the other important quantities, and these are also readily ascertainable. The comparison thus made is that of the heat produced at the generator, with the power derived from it; and, this comparison being effected, it becomes easy to calculate, from the data thus obtained, what is the actual efficiency of the engine; what are the wastes, and in what direction they occur; and, finally, in what direction improvement may be looked for, and to what extent it is possible.

Mr. Mair's trials were made with several engines, and in some cases with the same engine under varying conditions. Of the engines tested, one was a single-cylinder beam-engine, one was a 'Bull-Cornish engine,' and the others were Woolf arrangements of the compound engine. With the first of these engines, steam was carried at from 56 to 59 pounds' pressure, measured from vacuum. The speed of piston was from 222 to 240 feet per minute, and the ratio of expansion varied from 2 to 4.33. The steam used was practically dry, containing, by observation, but one per cent of water. The amount passing through the jacket was from 4.4% to 4.9%, except on one occasion, when the jacket-steam was entirely shut off. The power of the engine was from 120 to 125 horse-power, as shown by indicator.

The proportion of water condensed in the cylinder, up to the point of cut-off, varied from 15% to 30%, as the ratio of expansion increased from 2 to 4.33, and was brought up to 37% at the ratio 3.84 by shutting off the jacket. The heat supplied to the engine, measured in British thermal units, varied from 416 to 516 per horse-power per minute; the best work being done, and most economy exhibited, at a ratio of expansion of 3.16. When the jacket-steam was shut off, the consumption of heat amounted to 516 units per minute. The consumption of steam amounted to from 21 to 26.5 pounds per horse-power per hour. The theoretical efficiency was from 25% to 27%, while the actual efficiency was from 8% to 10%, or from 33% to 37% of that estimated on the assumption of perfect freedom from wastes other than the necessary thermodynamic waste of the perfect engine.

Comparing these figures, it will be seen that the cylinder waste amounts, in this engine, to about ten or twelve hundredths the ratio of expansion, in percentage of the total heat or steam supplied in the cases of trial of the jacketed cylinder. Throwing off the jackets brings up the waste to a percentage equal to nearly fifteen-hundredths the ratio of expansion.

The 'Bull-Cornish engine' is a pumping-engine in which the steam-distribution is effected as in the ordinary Cornish engine; but the beam is dispensed with, and the cylinder is inverted and set directly over the shaft and pump-rod. It is thus impossible to use safely as large a ratio of expansion as in the common form of Cornish engine, the distribution of weights being less capable of a wide range of adjustment. In this case, the engine was worked with 55 pounds' absolute steam-pressure, at a piston-speed of 244 feet per minute, using dry steam at a ratio of expansion of 1.75. In this case, the amount of condensation at cut-off was 17%; the power was 175 horse-power; the heat used was about 624 thermal units per minute, and the steam 32 pounds per horse-power per hour; the theoretical efficiency was 23%, the actual 7%, and the latter was 30% of the former. The 'Bull-Cornish engine' is thus seen to be substantially equal to the single-cylinder, jacketed beam-engine in waste by condensation, but, on the whole, to be inferior to the latter in its consumption of heat and of steam under substantially equivalent conditions.

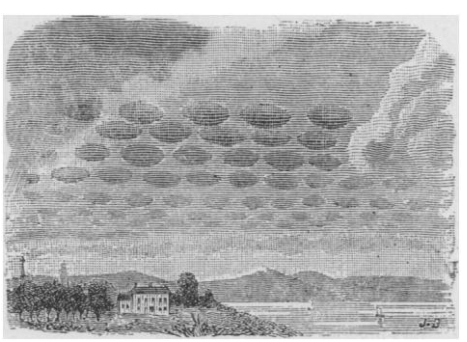
The Woolf compound engines were worked with steam varying from 67 to 78 pounds' pressure, absolute, with piston-speeds from 284 to 368 feet per minute, and at ratios of expansion varying between 10 and 16.5. Their power ranged from 133 to 215 horse-power, and the amount of heat supplied ranged from 296 to 324 thermal units per horse-power per hour. The cylinder-condensation ranged from 24% to 31%, or about eight times the square root of the ratio of expansion, in per cent, of steam supplied. The engines used from 15.12 to 16.6 pounds per horse-power and per hour. The efficiencies, theoretical and actual, were from 25% to 30%, and from 13% to 14%; the latter quantity being nearly one-half the former. The consumption of steam, on these trials, is extraordinarily low, — the lowest on record, probably, — and should be checked by repeated experiment.

On the whole, these reports present the class of data that the engineer greatly needs, both for the purpose of determining the direction and the limitations of further improvement of the steam-engine, and for the purpose of securing a more practically applicable theory of the real, as distinguished from the ideal heat-engine. R. H. THURSTON.

METEOROLOGICAL NOTES.

THE Russian meteorologist, Woeikof, known in this country from his share in the final preparation

of Coffin's great work on the winds of the globe, is one of the most industrious, as well as one of the best, writers among the modern meteorologists. He has lately published a good-sized volume on climatology, in Russian, from which a sample chapter on the influence of forests is translated in a recent number of *Petermann's mittheilungen*, to which we shall shortly refer. Besides this, the German and Austrian journals of meteorology contain frequent contributions from his study devoted largely to the discussion of the climate of the eastern dominions of Russia. Among these, that on the climate of East Siberia contains many facts of interest, especially in relation to the extremes of winter cold observed at Yakutsk and other low inland stations, where the average January temperature is close about the freezing-point of mercury. It is found that the excessive cold that characterizes the long, clear, quiet winter nights of that region is most severe in the low valleys, while the elevated stations have a distinctly milder winter, although still surely cold enough; so that at this season the air is generally warmer at a moderate altitude above the earth than at its surface. This inversion from the normal decrease of temperature vertically, had already been inferred by Hann to be a characteristic of the cold season of continental interiors, but its best observational proof is now given by Woeikof. It results directly from the ease with which the land cools by excessive radiation in winter, while the air which is slower to lose its warmth departs less from its average annual temperature. An example of a similar condition in this country is given in an account of the cold island in Michigan, by Alexander, in a late number of the *American meteorological journal.*



CLOUDS SEEN IN MEURTHE-ET-MOSELLE.

Millot, secretary of the Meteorological commission of Meurthe-et-Moselle, describes in *L'Astronomie* some very singular clouds which he observed in the morning of Dec. 18, 1882, directly after a rain-storm and severe squall from the west. Scattered equally throughout the pallio-cumulus rain-clouds were hemispherical grayish pockets slightly elongated, which Millot calls globo-cumulus clouds. They are represented in the accompanying cut.

Elfert, in his paper on cloudiness in central Europe, presents statistics of cloudiness from three hundred and nineteen stations scattered generally throughout western Europe between latitudes 39° and 60°, and longitudes 4° and 30°. The stations range in height from near sea-level up to nearly nine thousand feet above. The periods of observation vary from one year to forty or more, and few stations have been occupied for a less period than three years. Statistics of the monthly, seasonal, and annual percentages of cloudiness are given for all these stations, showing a mean percentage of cloudiness in central Europe, in winter, of 69; in spring, of 59; in summer, of 55; and in autumn, of 64. The mean of the year is 62%. Over the greater part of the area under discussion, the maximum of cloudiness is reached in winter, and the minimum in summer; but in the alpine region these conditions are reversed, while in the low region of Holland and Belgium the maximum is in spring, and the minimum in the autumn. The distribution of the annual cloudiness shows little appearance of design, further than the general fact that cloudiness is more general in the northern than in the southern part of the area. The general tables are succeeded by discussions concerning the relations of relative humidity and of the direction of the wind to degree of cloudiness, and of the relative proportions of cloudiness at different times of the day. The paper is illustrated by maps and diagrams.

THE RUSSIAN EMBASSY TO AFGHANISTAN.

THE origin and growth of the present Russian empire are intimately connected with the courses of the great rivers of Russia. Between the White Sea and the Pontus Euxinus, the Baltic and the Caspian seas, the country, totally devoid of dominating elevations, bears the character of an extensive lowland, stretching towards the south. Orographically it may be considered as the continuation of the plains of central Asia, with which it is connected. Over this tract of land various Slavonic tribes, the present Russians, have been spreading at a more or less rapid rate, especially in a south-eastern direction. Subjugating those who offered resistance, they ever remembered the words, 'to conquer, or to perish,' — the proud device of Swätosloff, their first great leader. Unlike the bloodthirsty Asiatic warriors, themselves an agricultural people, they were the bearers of civilization, whether they moved toward the north, east, or south. In some directions their progress necessarily had to be slow; but it has steadily been going on for the past two thousand years.

Reise der russischen gesandtschaft in Afghanistan und Buchara in den jahren 1878-79, von Dr. J. L. JAWORSKIJ. *Aus dem russischen übersetzt und mit einem vorwort und anmerkungen versehen*, von Dr. ED. PETRI, docent für geographie und anthropologie an der Universität Bern. Bd. i. Jena, *Costenoble*, 1885. 12+427 p., illustr. 8°.